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TRENDS AND PROSPECTS IN WORLD FISHERIES

by

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PREPARATION OF THIS DOCUMENT

Reviews of major trends in world fisheries have in the past proved a useful background, against which the work of the Fisheries Department and its development projects could be formulated and assessed. Such studies have also proved to be much in demand by readers outside FAO. Previous reviews have included the work undertaken in connection with the Indicative World Plan and Agriculture towards 2000. As this later study is now out of print and somewhat out of date (although issued in 1982 it was based on data pertaining largely to the mid-seventies) a new and rather less quantitative review has been made in the present document. At the time of preparation of this paper the author was Senior Fishery Economist with the Interregional Project for the development of fisheries in the Eastern Central Atlantic (CECAF).

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ABSTRACT

The document reviews the role of fisheries in nutrition and some of the main developments which have affected the supply of fish to world markets. It reviews the effect of fluctuation in the catch of 20 or so main species contributing to world fish supplies. It examines some of the factors likely to influence both future supply and demand. Among these on the supply side are management of wild fish stocks as well as possible increases in production from aquaculture; on the demand side are population growth, increases in *per caput* income and changes in relative prices. The implications of the likely impact of these factors is also examined.

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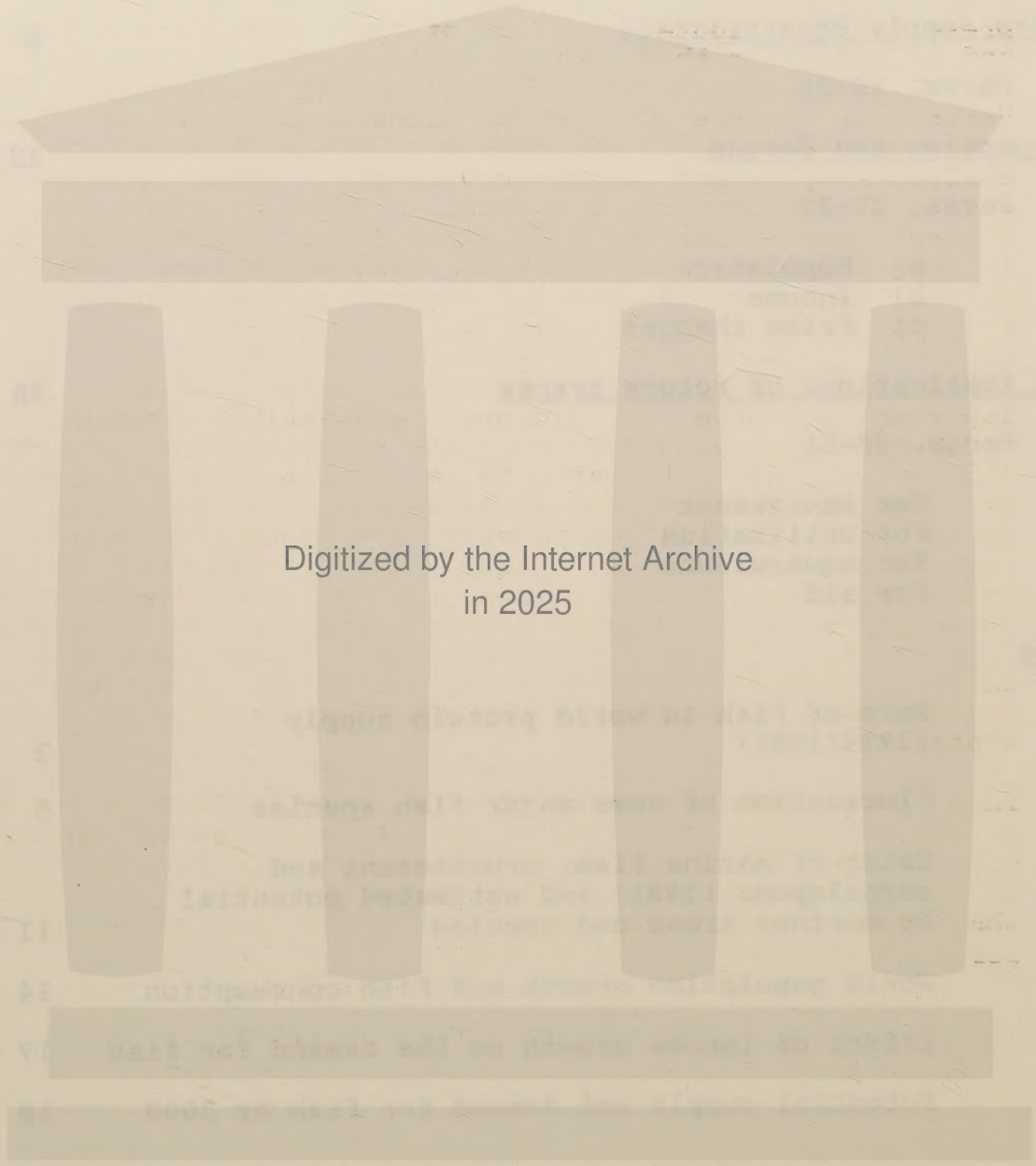

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TRENDS AND PROSPECTS IN WORLD FISHERIES

Introduction

1. Generally less subject to taboo in its consumption and probably less confined geographically in its production than many livestock products, fish is one of the most widely distributed food commodities in the world. It presently contributes about 6% of the total protein supply, and allowing for the indirect contribution of fish meal fed to animals, about 24% of total animal protein supplies. Variations in the pattern of consumption are determined both by cultural factors - resting historically on availability - and on income levels. Thus the highest levels of consumption are found in Japan, Iceland, Norway, Denmark, etc. but the most vital impact of fish is found in the developing countries of Asia and Africa where the animal protein intake is generally low but a high proportion of it is provided by fish.

2. Apart from its role as a provider of food, fishing is an important source of income generation through the inducement it provides for the establishment of other industries and it can be a generator of economic development. Present estimates suggest that throughout the world some 15 million people are engaged directly in fishing but such global figures give little feel for the vital importance which fishing has for many small coastal communities which have little alternative employment opportunity. The good management of the resources on which these communities depend is essential to their economic health, and through this to the maintenance of social stability.

3. This paper examines some of the main influences on the growth of world fisheries in the recent past and analyses some of the implications of existing trends for the future of world fisheries. On the basis of this it identifies what seem likely to be important fields for action in the period to the end of the century.

Table 1: Role of fish in world protein supply (1979/1981)
(Grams per caput)

	World	Africa	North-Central America	South America	Asia	Europe	Oceania	USSR
Total	67.6	59.8	92.4	66.2	56.3	99.2	84.3	99.7
Vegetal	44.4	46.8	37.3	36.3	45.7	43.3	32.3	49.2
Animal	23.2	13.0	55.1	30.1	10.6	55.9	52.0	50.5
Meat/Offals	11.0	6.6	30.2	17.8	3.8	28.3	30.5	21.4
Eggs	1.7	0.5	3.8	1.5	0.9	4.2	3.0	4.2
Fish/Seafood	3.7	2.6	3.3	2.6	3.3	4.5	3.6	8.8
Milk	6.8	3.3	17.7	8.1	2.6	18.8	14.7	16.0
Fish proteins as a percentage of Total Protein	5.5	4.3	3.6	3.9	5.9	4.5	4.3	8.8
of Animal Protein	15.9	20.0	6.0	8.6	31.1	8.1	6.9	17.4

Source: FAO, ICS, Food Balance Sheets

Past trends in World Fisheries

4. The period since the end of World War II has been for fisheries - as for many other industries - a time of unprecedented change. For two decades from 1950 there was rapid growth during which the world catch increased from some 20 million to 65 million tons. Underlying this expansion was the growth in the world economy - in the fifties mainly in the developed world and in the sixties also in the developing world where the immediate post independence period of many countries saw a sharp increase in economic activity and output. Where this occurred it created the necessary conditions for an expansion of fishery production through, for example, an improvement in communications but above all through a growth in income and therefore market demand.

5. The growth in the world fish catch to meet this increasing demand was assisted by two technological developments which in their way were as revolutionary as the introduction of steam power to North Sea trawlers in the eighteen-eighties. These were first the introduction of synthetic fibres in the manufacture of nets accompanied by the mechanization of net hauling which made possible the use of large purse seines, and secondly the introduction of freezing at sea. This, together with the development of stern trawling permitting fishing in rough seas, led to a dramatic increase in the size and radius of operation of fishing vessels.

6. Synthetic twine was first used in gill netting where the use of thinner continuous filament twines led to the more effective gilling of fish and its rot resisting properties permitted more prolonged use but the main impact of synthetic twine on world fisheries has been its use in the construction of increasingly large seines, the operation of which was made possible by the almost simultaneous development of mechanical net hauling.

7. These large purse seines had probably their greatest impact on the fisheries of the Northern European countries where in the nineteen-sixties catches were doubled and against the general trend in world fisheries high rates of growth have been maintained right up to the early-eighties. Equally important, however, has been the impact of purse seining on the world tuna fisheries. In the US in the second half of the fifties the introduction of such capital intensive methods was a shot in the arm to an industry using labour intensive methods and suffering from increasing labour costs. Catches began to increase from the mid-sixties and from 150 thousand tons at that time, they are now around 230 thousand tons. The technique of purse seining combined now with fish attraction devices is continuing to gain ground, e.g. Japanese vessels so long wedded to long lining, are now under the pressure of economic forces adopting this method of fishing as are many developing countries.

8. Large purse seines also played an important role in speeding up the exploitation of the anchoveta in the South Eastern Pacific but the fish there were so dense and required such low catching efficiency that gear was not a critical factor in the expansion of this fishery. The main stimulus to the growth of this fishery was the market. During the ninteen-fifties at first in the United Staes and then in Western Europe a shift to intensive livestock production was taking place which brought in its train feeding with nutritionally balanced rations including in most cases fish meal. This gave rise to an increase in the demand for fish meal well in excess of that generated by the normal process of economic growth which in turn led to a greatly increased demand for shoaling pelagic fish such as the anchoveta.

Table 2: Fluctuation of Some Major Fish Species

million tons

		1960	1965	1970	1973	1975	1977	1979	1981	1982
1. Anchoveta	Engraulis ringens	3.482	7.681	13.660	1.705	3.319	0.811	1.413	1.555	1.832
2. Alaska Pollack	Theragra chalcogramma	0.506	1.042	3.057	4.617	5.024	4.296	3.944	4.177	4.475
3. Atlantic Herring	Clupea harengus	2.576	4.001	2.320	1.979	1.527	0.990	0.885	0.970	0.984
4. Capelin	Mallotus villosus	0.104	0.281	1.515	2.054	2.248	4.009	2.934	2.805	1.852
5. Chilean Pilchard	Sardinops sagax	0.044	0.050	0.011	0.186	0.228	1.492	3.346	2.812	3.252
6. Atlantic Cod	Gadus morhua	2.150	2.767	3.105	2.539	2.434	2.272	2.042	2.344	2.264
7. Japanese Pilchard	Sardinops melanosticta	0.078	0.009	0.017	0.301	0.530	1.471	2.156	3.613	3.966
8. South African Pilchard	Sardinops ocellata	0.662	1.037	0.627	0.495	0.662	0.326	0.096	0.100	0.089
9. Chub Mackerel	Scomber japonicus	...	0.808	1.975	1.836	1.956	2.309	2.433	1.783	1.592
10. European Sardine	Sardina pilchardus	0.473	0.519	0.607	0.949	1.070	1.113	0.742	0.991	0.897
11. Cape Hakes	Meluccius capensis,M.Pardox	0.077	0.332	0.765	0.906	0.656	0.598	0.454	0.342	0.445
12. Atlantic Mackerel	Scomber scombrus	0.180	0.349	0.682	1.028	1.098	0.687	0.763	0.634	0.630
13. Chilean Jack Mackerel	Trachurus murphyi	...	0.015	0.109	0.164	0.299	0.848	1.287	1.740	2.195
14. Sprat	Sprattus sprattus	0.248	0.187	0.241	0.517	0.993	0.644	0.662	0.595	0.525
15. Gulf Menhaden	Brevoortia patronus	...	0.464	0.549	0.487	0.543	0.447	0.807	0.553	0.854
16. Skipjack	Katsuwonus pelamis	0.128	0.248	0.403	0.561	0.548	0.637	0.703	0.746	0.762
17. European Anchovy	Engraulis encrasicolus	0.170	0.338	0.348	0.379	0.392	0.418	0.491	0.635	0.685
18. Pacific Thread Herring	Opisthonema libertate	...	...	0.420	0.116	0.152	0.393	0.544	0.640	0.573
19. Cape Horse Mackerel	Trachurus capensis	...	0.310	0.065	0.280	0.316	0.688	0.465	0.624	0.668
20. Large Head Hairtail	Trichiurus lepturus	...	...	0.562	0.804	0.698	0.597	0.648	0.762	0.794
21. Yellowfin	Thunnus albacares	0.271	0.256	0.362	0.447	0.496	0.536	0.538	0.560	0.536
22. Japanese Anchovy	Engraulis japonicus	0.426	0.473	0.420	0.431	0.421	0.386	0.296	0.345	0.360
23. Cape Anchovy	Engraulis capensis	...	0.178	0.358	0.558	0.409	0.368	0.570	0.491	0.390
Others		...	27.335	33.872	39.319	39.981	42.155	43.018	45.241	46.153
TOTAL		**35.600**	**48.700**	**65.450**	**62.658**	**66.000**	**68.491**	**71.237**	**75.053**	**76.773**

9. The second major innovation was freezing at sea pioneered in the late-fifties by British vessels in the North Atlantic and rapidly adopted by the USSR and the Eastern European countries and to a lesser extent by Japan and some countries of Western Europe. By the early nineteen-fifties Japan was already the world's most important fishing nation taking around one sixth of the world catch but in order to maintain this position the radius of operations had continuously to be increased until by the late nineteen-seventies some 20% of the Japanese catch came from distant waters. It is interesting to note however that, even now this process has come to an end, Japan has been able to maintain catches of over 10 million tons due partly to the fortuitous recovery of the sardine stocks in domestic waters. In the case of the USSR and Eastern Europe the introduction of freezing at sea provided the basis for a tremendous expansion of fishing effort, which in 1976 took the catch of the USSR over 10 million tons or some 17% of the total world production, compared to only 8% in 1950.

10. Much of the expansion in the developing countries has been due to the transfer of technology. This has been particularly the case in Thailand and other countries of Southeast Asia where the introduction of the single boat trawl led to a rapid growth in catches during the nineteen-sixties and later in many cases to over-exploitation. Technology transfer has played its part also in Africa. In Ghana, for example, the introduction of the ring net was the start of the growth of a considerable industrial fishery, and the introduction of small purse seines has had a significant impact on the artisanal fisheries in many parts of West Africa. Many of these developments would not have been possible however had there not been entrepreneurial skills available to exploit the new technologies. This was a crucial factor in the growth of the Korean fisheries which now produce some four times the landings of the early-sixties - with at least a commensurate increase in value. The considerable foreign assistance which the Republic of Korea received probably served only to accelerate what was an autonomous development; technology transfer also played a part - particularly in the tuna fisheries where many of the crews had worked on Japanese long liners.

11. In the seventies this hitherto rapid expansion of world fisheries came up against a resource barrier and rates of growth slowed dramatically from around 6% per year on average to around 1%. The cause of this decline is clear from Table 2 which shows the yield pattern for the 20 or more major species comprising the world catch. The predominant influence is that of the anchoveta fished by Peru and Chile which collapsed dramatically from a peak of 13.7 million tons in 1970 to less than a million tons today, but other not negligible declines have been recorded by the Atlantic Herring (Clupea harengus) and the South African Pilchard (Sardinops ocellata) which had reached the peak of their production in the late-sixties. Catches of Atlantic Cod (Gadus morhua) also declined throughout the seventies and many other species landings of which had risen during the sixties failed to show any growth.

12. The over capacity which had been created in the expansionary sixties led to a search for other less exploited species in order to avoid economic disaster. In the North East Atlantic attention was diverted to capelin (Mallotus villosus), the catch of which rose to a peak of 4.0 million tons in 1977 from which it is now declining. More recently the level of world catches has been maintained by the Japanese sardine (which had collapsed around 1940 and suddenly reappeared in the seventies) and by increased catches of the sardine in the South East Pacific which seems to have substituted the anchoveta.

13. Accompanying the rise and decline of these substantial shoaling pelagic species has been a steady growth in quantitatively smaller fisheries producing fish of high commercial value, e.g. tuna and crustaceans. Thus the rate of growth of the value of the world catch has fallen less sharply than a simple analysis of physical catches would suggest. Furthermore, since many of the fisheries which have declined were producing raw material for fish meal plants and those which have continued to grow are food fisheries, the contribution of the sector to human nutrition has been maintained.

14. World trade in fishery products has also continued to grow and between 1970 and 1980 showed a 410% increase in value and a fourfold increase in volume; the total value of fishery products exchanged as international trade in the latter year exceeded 15,000 million dollars. Apart from price inflation the more rapid increase in value is due to a marked shift in the commodity composition of trade with frozen fish now accounting for some 43% of the total (in quantity) against 29% in 1970; frozen crustaceans have also increased their share of the total. Offsetting these increases the proportion of fishmeal in total trade has fallen from 40% to 23%.

Future Supply Possibilities

15. The present level of exploitation compared with the commercially realizable potential of broad groups of conventional types of marine fish crustaceans and cephalopods is reviewed in Table 3. The term commercially realizable implies that the potential of each stock considered in isolation has been discounted to allow for the fact that for reasons concerned partly with species interaction and partly with the taking of unintended catches of one species while fishing for another, it is practically impossible to exploit all stocks to 100% of their potential. The table also excludes molluscs (other than cephalopods), the widespread possibility for the cultivation of which renders the concept of potential of less significance; for the same reasons it includes no estimate of the possibility of culturing marine fish which will be discussed later.

16. The data in the table suggests that catches of those conventional types of fish identified could be increased by some 20-30 million tons but it is necessary at once to qualify this somewhat optimistic picture. In the first place it should be stressed that only a part of this increase will be realizable through increased fishing and a substantial part, probably not less than 50%, will be achieved only by better management or other factors which permit the recovery of stocks from which the yield is presently depressed. This concerns principally the shoaling pelagic fish, e.g. the Peruvian Anchoveta (Engraulis ringens) or the North Atlantic Herring (Clupea harengus). These and other similar fisheries appear to be subject to periods of alternating high and low abundance stretching over decades. This is known from records of the herring fishery in the Baltic at least as far back as the sixteenth century but a more recent example is the Japanese sardine (Sardinops melanosticta) the change in the catches of which have been referred to earlier.

With the stocks such as these the present state of knowledge makes prediction nearly impossible but apart from refraining from fishing there is little that man can do to restore yields to their former levels.

17. Estimation of possible yields from shoaling pelagic species is also complicated by evidence showing that when the abundance of one species is low the abundance of other species may increase - a change which was previously referred to as replacement, implying some sort of functional relationship but which seems to be a change of a much more coincidental nature. Examples which come to mind include the Californian sardine/anchovy relationship and that between the increased catches of Sardinops sagax and the decline in the yield of Peruvian anchoveta. Whatever the relationship between these changes and the cause, for present purposes it is sufficient to note that they make prediction for the basis of planning a more hazardous exercise than usual.

18. For demersal fisheries prediction of yields is possibly a little easier although changes in year class variation such as affected the haddock in the North Sea in 1962 can have a marked effect on catches, and there is evidence that some species may be subject to long-run changes in abundance due to climatological or other factors. Nevertheless, the possibilities for increasing the catch of demersal species is limited. Here however it is necessary to distinguish between catches and landings, two terms which are often used synomymously. Presently many demersal species are already caught (in shrimp trawls) and not landed and the problem is again not one of increased fishing but of providing incentives for the landing and marketing of this fish.

19. So far as increased fishing could yield higher catches (and landings) possibly the only remaining area which any substantial potential still exist is the South West Atlantic. Increased exploitation of these stocks has already begun but appears to have been temporarily halted by economic, i.e. marketing problems associated with the general world-wide recession. Elsewhere scattered stocks exist but generally those that remain unexploited are in this condition since the cost of harvesting them would not be justified by the revenues obtained from the sale of the fish caught, and their exploitation will have to await some change in the cost/price structure.

20. For shellfish the possibilities of increased production are mixed. Cephalopods (squids, cuttlefish, octopus, etc.) are in some areas of the world only lightly exploited but at the same time are regarded as conventional foods in only a handful of countries. Consumer acceptance is also a factor likely to govern the production of mussels, theoretical possibilities for the production of which by culture are very large indeed. Given the control of pollution and the availability of seed, good prospects exist for the culture of other molluscs such as oysters, clams and scallops. Crustaceans on the other hand are generally heavily exploited but locally some increases in catch can be looked for e.g. from smaller crabs and from some shrimps including those in deeper waters and in some as yet relatively under-exploited areas, e.g. the northwest coast of Australia. In the long run, however, it is clear that the supply of shrimps is likely to become increasingly inelastic and thus the consequent rising prices will give impetus to the culture of these animals. Nevertheless, prices do not yet seem to have risen enough to make the intensive rearing of shrimps, where feeds and other current inputs add to costs, a generally attractive commercial proposition and production increases over the next decade will most likely come from the expansion of extensive culture. This however requires substantial areas of land and is thus for large commercial enterprises rather than small farmers. Whatever happens however, even though increasing and likely to double or treble, the amount of shrimp cultured by the end of the century is likely to remain small, i.e. less than 5% of total production.

21. Given the existence of the appropriate environmental conditions (temperature, salinity, etc.) and the availability of fry, the problem of expanding aquaculture for fish is basically economic although as always such generalizations can be misleading. In parts of Africa and doubtless elsewhere captured fish is still sufficiently abundant to make aquaculture for most species a doubtful economic proposition although the situation may well have changed by the end of the century. In other areas, in the lagoons along the Eastern Central Atlantic for example, cage culture (or other more traditional forms of culture) could be a profitable undertaking but this would often require high technology and the risky nature of the venture again makes it suitable only for large commercial organizations although this might provoke, or exacerbate already existing social problems among the lacustrine communities.

Table 3: Catch of Marine Fish, Crustaceans and Cephalopods (1981) and Estimated Potential by Marine Areas and Species

million tons

	Oceanic Pelagic		Demersal		Shoaling Pelagic		Cephalopods		Crustaceans		TOTAL	
	1981 Catch	Potential	1981 Catch	Potential	1981 Catch	Potential	1981 Catch	Potential	1981 Catch	Potential	1981 Catch	Potential
ATLANTIC OCEAN												
Northwest	0.02		1.26	2.0-2.5	0.56	1.4-1.8	0.05		0.20	0.14-0.18	2.09	
Northeast	0.06		5.75	4.3-5.3	5.01	5.8-7.0	0.04		0.18	0.15-0.19	11.04	
Western Central	0.07	0.8 - 1.0	0.39	1.6-2.3	0.79	1.6-2.8	0.01	0.4-0.6	0.26	0.29-0.35	1.52	
Eastern Central	0.25		0.96	0.7-0.9	1.85	2.2-2.8	0.15	0.18-0.22	0.04	0.02-0.04	3.25	
South Western	0.02		0.85	1.6-2.4	0.31	1.0-1.4	0.05	0.8-1.1	0.10	2.09-0.13	1.33	
South Eastern	0.04		0.60	0.7-0.9	1.68	1.8-2.2	0.01	0.03-0.05	0.01	0.03-0.05	2.34	
TOTAL Atlantic	0.46	0.8 - 1.0	9.81	10.9-14.4	10.20	13.8-18.0	0.31	2.01-2.97	0.79	0.72-0.94	21.57	28.23-37.31
PACIFIC OCEAN												
Northwest	0.72		9.21	8.1-9.9	6.62	5.4-6.6	0.69	0.7-0.9	0.82	0.36-0.44	17.97	
Northeast	0.37		1.65	1.7-2.1	0.08	0.9-1.1	0.01	0.06-0.10	0.14	0.22-0.26	2.25	
Western Central	0.76	2.0 - 2.4	2.48	2.6-3.8	1.67	3.2-4.0	0.13	0.13-0.19	0.53	0.43-0.53	5.57	
Eastern Central	0.39		0.39	0.6-1.0	1.60	1.6-2.0	0.03	0.4-0.8	0.12	0.32-0.48	2.53	
South Western	0.06		0.18	0.6-1.0	0.06	0.6-1.0	0.06	0.10-0.14	0.01	0.01-0.02	0.37	
South Eastern	0.04		0.29	0.5-0.6	6.37	3.2-9.6	0.00	0.32-0.44	0.02	0.06-0.08	6.72	
TOTAL Pacific	2.34	2.0 -2.4	14.11	14.10-18.40	16.40	14.90-24.30	0.92	1.71-2.57	1.64	1.40-1.81	35.41	34.11-49.48
INDIAN OCEAN												
Western	0.18	0.5 - 0.7	0.88	1.0-1.4	0.75	1.7-2.8	0.01	0.19-0.29	0.29	0.20-0.30	2.11	
Eastern	0.08		0.95	0.8-1.2	0.29	0.7-1.0	0.01	0.13-0.19	0.09	0.09-0.13	1.42	
TOTAL Indian	0.26	0.5 - 0.7	1.83	1.80-2.6	1.04	2.4-3.8	0.02	0.32-0.48	0.38	0.29-0.43	3.53	5.31-7.51
MEDITERRANEAN	0.06	0.04-0.06	0.35	0.35-0.45	1.06	0.7-0.9	0.05	0.05-0.07	0.03	0.03-0.05	1.55	1.13-1.47
ANTARTIC												
WORLD TOTAL	3.12	3.3 - 4.1	26.10	27.15-35.85	28.70	31.80-46.50	1.30	4.09-6.09	2.84	2.44-3.23	62.06	68.78-95.77

22. Among the less conventional marine resources those most likely to support fisheries in the future include krill, mesopelagic species and oceanic squid. Krill, in fact, already supports a fishery of over 400,000 tons annually. Most of this is taken by vessels from the USSR and converted into meal. Although little is known about the economies of this operation it seems unlikely that private investment would be profitable. Japan also has a fishery for krill, until recently subsidised and it has to be seen how this will fare now that it is being run on a purely commercial basis. The market remains limited and one of the major problems - as it has always been - is that in order to provide a product which is commercially competitive with other forms of animal protein the scale of any operation would have to be very large, perhaps providing krill in greater quantities than most markets could absorb.

23. Somewhat further away is the utilization of mesopelagic species - the small boney fish found widely distributed throughout the world's oceans but locally - e.g. in the Arabian Sea, in considerable abundance. Some limited exploitation and some research and development work has been undertaken on these types of fish and while it seems there are few technical problems in their harvesting, the difficulty as ever lies in the development and marketing of suitable low cost products. The size of these fish and their boney nature makes it almost certain that for the foreseeable future they would have to be used for the production of meal and at present with demand for protein feeds in general at a low ebb, and fishmeal having difficulty competing with other ingredients, the economic incentive for research and investment in this field is lacking.

24. Rather less is known concerning oceanic squid but the costs of harvesting these animals in the open ocean, below the surface and perhaps rather thinly spread over large areas is likely to be prohibitively expensive. Similar considerations apply <u>a fortiori</u> to most planktonic organisms which could technically be harvested and converted into products for human consumption but at great cost, although krill may yet prove to be an exception. Exploitation of the resources at lower trophic levels also raises the question of how dependent on them are predators, which are presently used as human food and it may well be that more human food at less cost would be obtained from the sea by husbandry and harvesting the larger animals than by attempting to exploit the microscopic plankton.

25. Inland fisheries contribute some 10% of world production of aquatic organisms and since all the catch is used for human consumption including some rather valuable species the contribution of inland fisheries to the value of production is probably higher than this figure. Production from inland waters is capable of some increase particularly from flood plain fisheries in Latin America and to a lesser extent in Africa. These fisheries are however vulnerable to interference by man for purposes of irrigation, electricity generation and other forms of control which almost inevitably - although they need not - reduce the production of these fisheries. Thus many of the flood plain fisheries now under-exploited may never yield their full potential and others fully exploited on which many communities depend could have their productivity reduced.

26. Against this some increase in production from the resulting reservoirs can be expected but in general this often falls far short of the loss in production from the flood plains. Production from various types of aquaculture can also be expanded given the provision of seed, the supply of water of the right quality, and in intensive aquaculture a commercially adequate input/output relationship.

Consumption and Demand

27. Taken together most of the factors discussed in the preceding section suggest a continuation of the slow growth in supply which has characterized the nineteen-seventies. But what of demand - will this continue to grow? In considering this three main factors need to be taken into account - population growth, income growth and price changes. Population is the most important of these factors since in a period of stable prices it will normally account for about two-thirds of the increase in total demand.

Table 4: World Population Growth and Fish Consumption

	Population (million)			Fish Consumption (Kg/Head)	Growth in fish production ('000 tons) required to meet population increase by	
	1980	1990	2000	1980	1990	2000
World	4,432	5,242	6,119	11.4	9,158	19,156
More Developed Regions	1,131	1,206	1,272	22.1	1,653	3,111
Less Developed Regions	3,301	4,036	4,847	7.75	6,569	13,136
Africa	377	515	699	8.7	1,180	2,781
Latin America	364	459	566	7.4	697	1,488
South and South East Asia	1,273	1,556	1,849	8.3	2,615	5,047
Near East	177	234	298	3.9	213	462
Asian Centrally Planned	1,105	1,265	1,427	7.6	1,843	3,217
Oceania	5	7	8	30.0	30	30

(a) Population

28. World population will continue to increase but at a declining rate - from the present level of about 1.8% per annum to around 1.5% by the end of the century. In spite of this, annual increments to total will continue to grow from their present level of some 75 million to reach a peak in the last quinquennium of the century of nearly 90 million. Thereafter the annual addition of people to the world population is expected to decrease 1/. However, of perhaps greater significance to the present analysis is that by the year 2000 a world population of some 6.1 billion people will at 1980 levels of consumption require an additional 19 million tons of fish.

29. The significance of these global trends cannot be understood without some recognition of the divergent growth trends between the more or less developed regions. In the industrialized countries annual average increments to the population are of the order of 7-8 million. But the year 2000 the share of these countries in the total world population will, compared with 1980, have fallen by five percentage points to 20%. The estimated growth in fish supply of over 3 million tons required to maintain present levels of consumption is therefore more a reflection of the already high level of intake than it is of the modest growth in population.

30. The less developed countries on the other hand already contain 74% of the world population and account for about 90% of the annual increase and it is in these countries that the impact of population increase on the demand for fish is the greatest. This is particularly the case in South and Southeast Asia where an additional five million tons will be required by the end of the century to maintain present levels of consumption. This region contains a number of countries where fish plays a vital role in the diet; e.g. the Republic of Korea, Indonesia, Bangladesh, Philippines, Burma, Sri Lanka and Thailand, in all of which fish accounts for a half or more of the animal protein supplies.

1/ World Population Prospects as Assessed in 1982, prepared by Population Division, Department of International, Economic and Social Affairs of the United Nations Secretariat, November 1983.

Fish is also an important item in the diet of many African people particularly in the western half of the continent and some of the countries in this area also have very high rates of population increase, but the relatively smaller populations suggest that with one or two exceptions, e.g. Nigeria, the problem of maintaining the supply of fish will, in general, be easier than in Asia.

(b) Income

31. So far consideration has been given only to the maintenance of present levels of consumption. Many people - possibly more in the low rather than the high income countries would however eat more fish if they had more money. Projections of income growth are more hazardous than those of demographic trends and tend to be much influenced by currently prevailing economic conditions which can change rapidly. The projections given in Table 5 assume a situation in which GDP in the industrial countries grows annually at 2.8% and in the developing countries at 4.5%. These rates were derived from the World Bank Development Report for 1982 and are not strictly projections but the basis for a development scenario. Although the outlook is in some respects now less gloomy - the conditions which would have to be met to achieve significantly more rapid growth suggest that these rates still provide the basis of realistic projections. 1/

1/ See in particular World Development Report 1984. New York. Oxford University Press, Chapter 3.

Table 5: Effect of Income Growth on the Demand for Fish

	1980		1990		2000	
	kg/caput	Total million tons	kg/caput	Total million tons	kg/caput	Total million tons
World	11.4	50.6	12.2	63.7	12.9	79.0
Developing Countries	7.8	25.0	8.8	35.5	9.8	47.5
Developed Countries	22.0	25.6	23.4	28.2	24.8	31.5

32. Table 5 shows that the effect of this rather modest growth in income is to raise per caput consumption in the developing countries by a kilogram in each decade and by rather more in the developed countries. The effect on total demand at the world level is to raise it by some 10 million tons over what would be required to maintain constant per caput consumption. Comparison of the supply and demand estimates in the preceeding section might be summarised as in Table 6.

Table 6: Potential supply and demand for fish by 2000

	Estimated Potential for Increased Production 1980 (million tons)	Required Increase in Supply by 2000 (million tons)	
Demersal	1.0 - 10.0		
Shoaling Pelagic	3.0 - 17.0	Developing Countries	22.5
Cephalopods	3.0 - 5.0	Developed Countries	5.9
Other Molluscs	1.0 ?		
Freshwater and Aquaculture	5.0 ?		
TOTAL	13.0 - 38.0		

33. Such rough order of magnitude comparisons should not be taken too literally. Some of the problems of estimating supply (e.g. the extreme variability of pelagic stocks) have already been mentioned; at the same time in real world markets such aggregates as pelagic and demersal have little meaning and demand and supply is for rather specific fishery products, the most preferred of which have long since been fully exploited. With modern marketing methods and the inevitable rise in the price of the preferred species, demand can be shifted to other species but this can be a long process and for decades the world fisheries scene has been characterized by strongly demanded fully exploited and expensive species existing alongside abundant cheap and good quality fish experiencing marketing difficulties.

34. This latter describes well most of the shoaling pelagic fish, some two-thirds of the world catch of which is presently used for the production of fishmeal. This is also the group of species that in spite of their apparent unreliability has the greatest potential for increased catches, but marketing problems will probably ensure that mush of any increase in the catch of these fish will also have to be used for the production of meal.

35. In principle these fish could be utilized for direct human consumption and in fact efforts in this direction have been underway for many years. The problems seem not so much technical as human and economic; there is not much difficulty in canning, drying or smoking pelagic species, or even producing an acceptable fish protein concentrate from them, but the problem is to do so at low enough cost or to convince people to substitute them for other types of fish (or other low cost food). It seems that notwithstanding the continuous rise in the price of Baccalao dried sardine will have difficulty in finding a market.

(c) Price changes

36. The main incentive to a shift in demand from one species to another is in theory provided by a rise in the price of the fully exploited species. There are as yet no studies available to document this but there is some evidence to suggest what is predictable in theory is being borne out in practice, e.g. in some developed countries a shift from canned Salmon to Tuna and in West Africa certain species formerly discarded from shrimp trawlers, e.g. cat fish are now retained and as prices rise this process will doubtless be extended to other species as in Britain, for example, halibut was once regarded as little more than trash fish.

37. Within many countries however there is clear evidence both of a sharp increase in the price of many of the less abundant species e.g. lobster, shrimp, etc., as well as a more rapid rise in the price of fish generally (i.e. those species appearing in the Cost of Living Index) as compared to meat and other forms of animal protein. In Japan, for example, the world's largest market for fish, taking 1970 as 100 the price of fresh fish and shellfish entering into the retail price index, had by the first half of 1982 risen to 343 compared with 210 for meat and 253 for all commodities. The same pattern is repeated in most Western European countries. In Italy, for example, Baccala (dried salted cod), which in the mid-sixties was half the price of beef, is now more expensive. This trend is not confined to the high income countries. In Korea, in the second half of the seventies, fish prices increased more rapidly than other food prices and nearly twice as rapidly as the price of meat, and in Brazil (Rio de Janeiro) although quality for quality fish remains generally cheaper than meat, its price throughout the seventies has been increasing at a faster rate.

Some implications of future trends

For management

38. The outlook for world fisheries analysed in the preceeding section has of course implications for policy makers, administrators, entrepreneurs and others concerned with the fishery sector. The fifties and sixties were in most parts of the world a period of expansion with a rapid growth in fishing effort brought about by both more vessels and new technology. However, as more stocks became first fully and then over exploited there was a growing interest in management problems although there was not yet a generalized conviction that action in this field was widely necessary. In fact there were those who claimed that the process whereby effort was transfered to a new stock as old ones become fully exploited had not yet worked itself out and should be allowed to continue relatively unfettered.

39. By the seventies however, there were few new stocks to which effort could be transfered, and in the middle years of the decade the impact of sharp rises in the cost of fuel made many fisheries ventures at least temporarily, unprofitable. More recently the rising price of fish has if only partially compensated for cost increases but if this process continues, which seems likely, the task of management authorities will be more difficult since with price increases fishing can still remain profitable in spite of declining yields. Much depends on the nature of the commodity (specifically on its price elasticity of demand) but there is here what might be termed a management trap, for with decreasing supply the price increases thus maintaining profits and perpetuating excessive capitalization in the fishery. It is in this basically conservationist argument that the main justification for fishery management lies.

40. Although management problems will continue to grow, the new Law of the Sea offers a better framework for their resolution than previous arrangements. Under the old regime authority for management of high proportion of the world's resources which were caught outside territorial waters lay with International Fishery Commissions. These, while having a positive impact on the development of methods for resource evaluation and on the understanding of the various problems of fisheries management met with limited success in maintaining yields from the fisheries. In fact these bodies were suitable for the technical aspects of the problems but not for the political aspects related to authority and decision making, but with authority now resting with the coastal state the management of many stocks, i.e. those falling within one EEZ has been much simplified.

41. Nevertheless, the establishment of sovereign rights in the fisheries in a coastal band of 200 nautical miles will not of itself ensure that the fish stocks - even those occuring exclusively in one national zone - will be well managed. In the past political pressures have complicated the task of the manager and seem likely to continue to do so. For politicians (and administrators) with whom the ultimate decisions rest, expansion is a much more rewarding policy than regulation - a fact which is not confined to fisheries policy but which is true of much economic policy in general. The construction of new vessels creates employment profits (for the shipbuilder at least) and votes, benefits which are immediate and tangible, whereas the benefits from good managements and the limitation of fishing effort are on the other hand long term and hypothetical. In the circumstances it is easy to see why governments tend to drag their feet over management action.

In addition, where stocks are shared by one or more country the problem is complicated by the need to obtain international agreement and there is not much evidence yet that this will be an easier process under the new arrangements than it was under the old Commissions.

42. Management however whether of solely owned or shared stocks needs a factual base concerning the status of the stocks and the effect of changes in fishing effort. Answers are needed to such basic questions as to how much fish can be taken without harmful effects on catches in future years. Already established organizations, e.g. ICES, are continuing to encourage research - particularly those concerned with fisheries in the temporate latitides. In the tropics FAO is playing an important role and in West Africa for example CECAF has been instrumental in either organizing or supporting groups of scientists concerned with specific stocks, e.g. Sherbro pelagic stocks and the mackerel stocks in the northern part of the region. A major problem remains however supporting and in some cases promoting research capability in the coastal countries not only in West Africa but elsewhere in the developing world.

For utilization

43. Future trends in world fisheries have of course implications for action in fields other than management. Some of these have already been alluded to and include processing and marketing and other ways of making better use of existing catches such as up-grading for human food, much of the fish now used for animal feed and utilizing the presently discarded catches of shrimp trawlers. These problems are already the subject of research and development work and as already noted the main difficulties are not technical but economic. It may be that the rising price of fish will eventually encourage commercial enterprise in these fields but the cost of producing protein through fish will through the price mechanism always face a challenge from other forms of protein production and reduction fisheries may continue to be a feature of the world fisheries scene for many years to come.

44. A major problem with the utilization of small pelagic fish whether used for human consumption or meal and oil, will continue to be their seasonal nature as well as long run changes in their availability, which creates difficulties concerning the size of the investment in facilities for handling, marketing and distribution. In addition, where marketing is for human consumption, the small and fragile nature of the fish and the high fat content which makes for rancidity requires that these fish are handled carefully.

45. A further difficulties lies in the fact that the potential markets for these species are with the poorer sections of the population but the improved handling and the processes required to make these fish available in an acceptable form and in the right place pose an economic problem that will not be easy to resolve. Detailed discussion of these difficulties is beyond the scope of these paper but they are considered by James 1/ who points out for example that although technical solutions are at hand it frequently happens that processes developed for raw material that is intrinsically cheap have such low yields as to increase raw material prices to levels at which a more appreciated species could be used.

For aquaculture

46. Economic considerations will also be a major factor influencing the growth in production from aquaculture which already seem to be benefiting from increasing fish prices but there are also other considerations particularly where the main thrust of development is to introduce fish as an additional crop to farmers rather than developing specific aquaculture schemes which as has been noted are likely to be rather capital intensive and lead increasingly to the industrialization of aquaculture. In almost all countries with a favourable natural environment the initial requirement is for organization, that is, for some agency (government, parastatal, private) to convince farmers of the benefits of aquaculture, to organize the supply of inputs, particularly fish seed, and assist with marketing. Once the commercial feasibility of a technology has been demonstrated the main requirement is for an extension service which in most countries implies a need for training.

1/ James, D., Fish for the future? Submitted for publication in Research in food science and nutrition. Vol.4. Proceedings of the Sixth International Congress of Food Science and Technology, Dublin, September 18-23, 1983. Dublin, Boole Press

47. The encouragement of the small farmer/aquaculturist, if successful, can make a significant nutritional impact in the rural areas of the low income countries. The development of commercial aquaculture in the high income countries on the other hand is likely to be largely a question of luxury species or at least species which will sell for a sufficient price to recoup the not inconsiderable cost of inputs. Much of the work on applying technology is likely to be undertaken by large firms with the financial resources to support innovative nutrition, but there will continue to be a need for research by universities and state organizations to advance technology, e.g. in the extension of aquaculture to new species, disease control, etc., as well as to supply technologists to the commercial enterprises.

For aid

48. The diverse states of development and the increasing irrelevance of a division of the world into developed and developing makes it difficult to generalize the implication of future trends in world fisheries for technical assistance and other forms of aid. If however there is one need which is felt in almost all but the most developed of third world countries, it is to improve support to scientific research in many developing countries has already been referred to although it has also been noted that this will not necessarily ensure that the scientific advice generated will be acted on.

49. Included under the heading of scientific research but meriting special attention is the problem of statistics, the reliability of which in many developing countries has been deteriorating over a long period. The problem here is also partly one of trained manpower but training is of no value if there is an inadequate system for the collection of data, and if there is no serious commitment to the maintenance of such a system.

50. Training in fact is often cited as a limiting factor in development generally. There is obviously a sense in which this is true in that people need to learn to navigate, operate gear and maintain machinery, etc., on the other hand the growth of some major fisheries in the past 20 years has been accomplished with very little formal training. While training has its value it may not be such a limiting factor as is claimed. On the job training, e.g. in the maintenance of motors, or in the use of new types of gear is probably more useful than more formal training scheme covering a range of subjects. Similarly, past experience has also demonstrated the value of workshops in such subjects as stock assessment or the theory and practice of management so long as such courses have a large heuristic element.

51. Clearly with growing pressure on the resources, any investment in productive capacity has to be highly selective; in any event, the main factor which is lacking for fisheries development in most countries is, in fact, not capital but management (in the sense of business management) and entrepreneurial ability. Past attempts to force the pace of development where these skills have been lacking have generally ended in failure and it is interesting to note that in many countries where the extension of limits has offered development possibilities to the coastal states, these are being taken up under some form of joint venture agreement, which bring with them the necessary management skills. Although some special projects will require capital input, e.g. aquaculture, the most valuable aid to the growth and development of fisheries to the end of the century in low income countries will continue to be technical assistance.